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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/655,972 | 09/04/2003 | Shing-Chyang Pan | 67,200-1137 | 8924 |

7590 05/16/2005

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EXAMINER

TRAN, BINH X

| ART UNIT | PAPER NUMBER |
|----------|--------------|
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1765

DATE MAILED: 05/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/655,972

Applicant(s)

PAN ET AL.

Examiner

Binh X. Tran

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 September 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 04 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

1. Claims 4 and 15 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim (claim 3). Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claims 4 and 15 are depended on claim 3. In claim 3, the applicants claim that the hydrogen containing ambient is proved at a pressure of "about 1 mtorr to about 10 mtorr". However, in claim 4 and 15, applicants try to broaden the pressure value by claiming "a pressure of about 1 mtorr to about 100 mtorr". Once applicants narrow the range to 1-10 mtorr, applicants cannot broaden range by reciting a new range of 1-100 mtorr.

Double Patenting

2. Applicant is advised that should claim 4 be found allowable, claim 15 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

3. Applicant is advised that should claim 5 be found allowable, claim 16 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both

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cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim.

See MPEP § 706.03(k).

4. Applicant is advised that should claim 6 be found allowable, claim 17 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof for the same reason as discussed above.

5. Applicant is advised that should claim 7 be found allowable, claim 18 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof for the same reason as discussed above.

6. Applicant is advised that should claim 8 be found allowable, claim 19 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof for the same reason as discussed above.

7. Applicant is advised that should claim 10 be found allowable, claim 20 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof for the same reason as discussed above.

Claim Rejections - 35 USC § 112

8. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

9. Claim 3-5, 14-16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 3, 5, 14 and 16, it is unclear from the claim whether the percentage (1%-20%, or 3%-10%) is in volume percentage, weight percentage, mole percentage, or other different concentration unit percentage.

Claims 4 and 15 are indefinite because they depend on indefinite claim 3.

Claim Rejections - 35 USC § 102

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

11. Claims 1, 3-12, 14-20 are rejected under 35 U.S.C. 102(e) as being anticipated by anticipated by Pan et al. (US 2004/0023485 A1)

The applied reference has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

Respect to claim 1, Pan discloses a method for forming a copper damascene feature comprising the step of:

providing a semiconductor process wafer comprising at least one via opening (30) formed extended through the thickness of at least one dielectric layer (26) and an overlying trench line (32) opening encompassing the at least one via opening (30) to forming a dual damascene opening (Fig 2A-2B, paragraphs 0029-0030);

etching through an etch stop layer (24) at the via opening (30) bottom portion to expose an underlying copper area (21B) (Fig. 2A, paragraph 0029);

carrying out an sub-atmosphere degas process with simultaneously heating of the process wafer in a hydrogen containing ambient (paragraph 0032);

carrying out an in-situ sputter clean process (paragraph 0035-0036);

forming a barrier layer (34) in-situ to line the dual damascene (paragraph 0037).

Respect to independent claim 12, Pan further disclose that the wafer comprises at least one via opening (30) formed extended through the thickness of at least one inorganic low-k dielectric layer insulating (26) and an overlying trench line (32) opening encompassing the at least one via opening (30) to forming a dual damascene opening (Fig 2A, paragraph 0027).

Respect to claims 3-4, 14-15 Pan discloses the hydrogen containing ambient is provided at a pressure of about 1-100 mtorr (paragraph 0032). Pan does not explicitly disclose the concentration of hydrogen in percentage. However, Pan clearly discloses the ratio of inert gas to hydrogen is about 5:1 to 20:1 with respect to total volume. Any person would be able to convert the volume ratio to percentage as following:

Ratio of inert gas to hydrogen 5:1

$$\text{vol\% of hydrogen} = 1/(1+5) * 100 \% = 16.66 \text{ vol.\%}$$

Ratio of inert gas to hydrogen 20:1

$$\text{vol\% of hydrogen} = 1/(1+20) * 100 \% = 4.76 \text{ vol.\%}$$

From the calculation above, the examiner interprets that Pan implicitly teaches to use 4.76 vol% to 16.66 vol.% of hydrogen (within applicant's range of 1-20%). The limitation of claims 5 and 16 has been discussed above.

Respect to claims 6-8, 17-19 Pan discloses the degas process is carried out at a temperature of 275-325 °C for 60 seconds to 180 seconds (paragraph 0032, read on applicants' range). Respect to claim 9-10, and 20 Pan discloses the barrier layer (34) comprises tantalum nitride (TaN, paragraph 0037). Respect to claim 11, Pan discloses the sputter clean process comprises hydrogen gas (paragraph 0035-0036)

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

13. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

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consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

14. Claims 1-2, 6-13, 17-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim (US 6,767,788) in view of Rozbicki et al. (US 6,554,914).

Respect to claim 1, Kim ('788) discloses a method for forming a copper damascene feature comprising the step of:

providing a semiconductor process wafer (11) comprising at least one via opening (19 and/or 24) formed extended through the thickness of at least one dielectric layer (12 and/or 15) and an overlying trench line opening encompassing the at least one via opening (19 and/or 24) to forming a dual damascene opening (Fig 1B, 1 D, col. 3 lines 50-67);

etching through an etch stop layer (14) at the via opening (24) bottom portion to expose an underlying copper area (13) (Fig 1D);

carrying out an sub-atmosphere degas process (col. 6 lines 41-43);

carrying out an in-situ sputter clean process (col. 6 lines 43-46);

forming a barrier layer (25) in-situ to line the dual damascene (col. 6 lines 46-60, Fig 1E).

Kim ('788) fails to disclose that the degas process is performed by simultaneous heating the wafer in a hydrogen ambient. However, Kim ('788) clearly teaches to perform a degas process. In a damascene process, Rozbicki teaches to perform degas process by heating the wafer in hydrogen ambient (col. 5 lines 40-49, col. 8 lines 59-60). It would have been obvious to one having ordinary skill in the art, at the time of

invention, to modify Kim ('788) in view of Rozbicki by heating the wafer with hydrogen ambient during the degas process because this technique will help to remove unwanted materials on the surface.

Respect to claim 12, Kim ('788) discloses the insulating layer is an inorganic low-k dielectric (e.g. silicon dioxide, col. 4 lines 48-51). Respect to claims 2 and 13, Kim ('788) further discloses: forming a copper seed layer in-situ to line the dual damascene opening; carrying out an electrochemical copper deposition (e.g. electroplated Cu) process to fill the dual damascene opening with a copper layer (26), carrying out a CMP process to remove the copper layer and the barrier layer above the trench (col. 6 line 55 to col. 7 line 3, Fig 1E-1F). Respect to claims 6-8, 17-19, Rozbicki teaches the degas process is carried out at 350 °C for 40 seconds (col. 8 lines 59-60, within applicants' range). Respect to claims 9-10 and 20, Kim ('788) discloses the barrier layer (25) is selected from the group consisting of Ta, TiN, TaN, TaSiN, and TiSiN (col. 6 lines 46-50). Respect to claim 11, Kim discloses the sputter-clean process comprises hydrogen gas (col. 6 lines 43-45).

15. Claims 3-5, 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim ('788) in view of Rozbicki as applied to claim 1 above, and further in view of Kim (US 2004/0127002).

Respect to claims 3-5 and 14-16, Kim ('788) and Rozbicki fail to disclose the specific concentration of hydrogen gas and the pressure. However, Rozbicki clearly teaches to use hydrogen gas to remove unwanted material. In a damascene, Kim ('002) teaches to remove unwanted material by using hydrogen and argon (inert gas) at

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a pressure of 1.5-3 mTorr (paragraph 0010, 0026, within applicant's range). Kim ('002) further discloses to use 2-15 sccm H₂ and 4-30 sccm argon. It is obvious to choose a specific gas flow rate within Kim ('002) suggested range. For example, any person having ordinary skill in the art would be able to calculate the volume percentage of hydrogen gas base on individual flow rate of 2 sccm H₂ and 30 sccm argon as follow:

$$\text{Volume \% of hydrogen} = 2 \text{ sccm} / (2 \text{ sccm} + 30 \text{ sccm}) * 100\% = 6.25 \text{ vol\%}$$

(Note: within applicant's range of 1%-20% or 3%-10%).

It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Kim ('788) and Rozbicki in view of Kim ('002) by using hydrogen and argon at the concentration and pressure as discussed above because this composition is capable of removing polymer and the copper oxide materials form during the etching process to expose copper area.

Conclusion

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Binh X. Tran whose telephone number is (571) 272-1469. The examiner can normally be reached on Monday-Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for

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published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only.

For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free).

Binh Tran

Binh X. Tran